

## The Southern Forest Resource Assessment: What We Learned

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**Abstract**—The Southern Forest Resource Assessment was initiated in the spring of 1999 to address broad questions concerning the status, trends, and possible future of southern forests. The overall objective of the assessment was to develop a thorough and objective description of forest conditions and trends in the South, and to present it in a way that would help the public understand a complex and dynamic resource. Findings of the assessment highlight the forces of change at work in southern forests and potential ecological and economic implications.

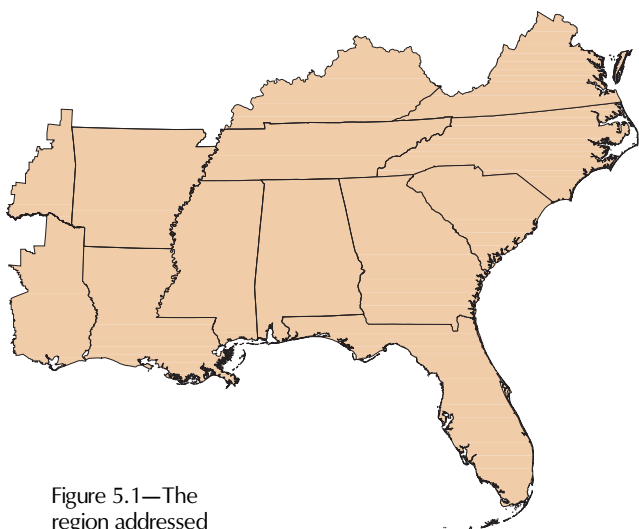


Figure 5.1—The region addressed by the Southern Forest Resource Assessment (Wear and Greis 2002a).

### INTRODUCTION

The forests of the Southeastern United States are diverse and dynamic. They have been utilized heavily since European settlement, and their current condition reflects a long history of land use. At the beginning of the 20<sup>th</sup> century, a 100-year period of intensive agricultural exploitation gave way to a period of forest recovery and growth. In the last quarter of the 20<sup>th</sup> century, however, timber harvesting and land development for urban uses increased substantially. As a result, questions have emerged regarding the health, productivity, and ultimately the sustainability of the South's forests and the benefits they provide.

The Southern Forest Resource Assessment (SFRA) was initiated in the spring of 1999 to address broad questions about the status, trends, and potential future of southern forests (fig. 5.1). The assessment was chartered by southern offices of the U.S. Department of Agriculture Forest Service, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the Tennessee Valley Authority; and it was conducted in collaboration with State agencies represented by the Southern Group of State Foresters and the Southeastern Association of Fish and Wildlife Agencies.

Approximately 89 percent of the South's forests are held by private owners. The assessment was, thus, a somewhat unusual undertaking, one in which Government agencies evaluated the status and future of a largely private sector of the economy. For this reason, the assessment was chartered as an information-gathering activity. The overall objective of the assessment was to develop a thorough and objective description of forest conditions and trends in the South, and to present this description in a way that would help the public understand a complex and dynamic resource situation. This role, i.e., monitoring change at a broad scale and describing cumulative change, has been described by the National Research Council (1998) as a logical and important role for Government in the area of private forestry.

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A descriptive assessment such as the SFRA can be used to highlight the major dynamics and uncertainties at play within a region's forested ecosystems, thereby focusing public discourse on the changes affecting these systems and on associated policy issues. Because the assessment has only recently been completed, it is too early to examine its effectiveness on such terms. In this chapter, we (1) examine the process that was used to structure and to conduct the assessment, (2) discuss the major findings of the assessment, and (3) examine the implications of these findings for the conduct of forestry and forest science in the South.

## ASSESSMENT PROCESS

The SFRA can be viewed as an exercise in what Lee (1993) has called "civic science." It was designed to be accessible to the public and to utilize considerable amounts of public input in the definition of issues, scope, analysis protocols, and review of outputs. It was designed to provide the public with a platform of current knowledge and data upon which to discuss and debate current and future issues regarding the South's forests.

### *Defining the Questions*

The first step in conducting the assessment was to define the set of questions that would be addressed. This was done by employing an approach utilized in the Southern Appalachian Assessment (Southern Appalachian Man and the Biosphere 1996). Initial sets of concerns were drafted by a group of about 75 experts from participating Government agencies using a workshop format and organized around 4 broad topic areas: (1) social-economic, (2) terrestrial ecosystems, (3) water and aquatic ecosystems, and (4) forest conditions and health. These concerns were then summarized into an initial set of questions that provided a framework for organizing public input.

To gather public input on the initial questions, two public workshops were conducted at each of five locations in the South. At each location, one workshop was conducted in the afternoon and the other in the evening. After presenting the audience with an overview of the project's objectives and general design, the group was divided into four separate sessions, each concentrating on one of four broad topic areas. In each of these sessions, the participants were encouraged to raise any concerns and issues that they felt needed to be addressed

by the assessment, and these were recorded and compiled. The initial questions were also posted on the SFRA Web site, and public comments were taken by mail and email.

The comments were then compiled using content-analysis software and were posted on the SFRA Web site. The assessment leaders then developed a preliminary set of questions that would address public concerns to the extent practical and consistent with overall objectives. Each of these questions was linked to the set of major concerns (labeled subpoints) on which the question was based. The questions summarized input from more than 700 participants, and the subpoints recorded the details of the major points summarized by the question. These preliminary questions and subpoints were posted on the SFRA Web site and were again reviewed by the public. The additional review input was used to further refine the questions.

### *Conducting the Analysis*

Each question defined the objective of an analysis of a resource or social issue related to southern forests. An individual scientist or analyst was selected by the SFRA planning team to conduct the analysis for each question. These individuals, who were called question managers, constituted the assessment team. The team was convened for an initial meeting with the objective of assessing the feasibility of and methods for addressing each question. Because of the potential for overlap of the analyses, question managers discussed their questions and approaches in groups organized by broad categories. Members of the public participated in these discussions and provided input regarding the question managers' interpretation of the questions and their proposed approaches.

Following the initial assessment team meeting, question managers prepared study plans that were posted on the SFRA Web site. These were also subject to public review and were eventually finalized. Analysis of the questions then commenced. Each question manager had the latitude to consult with various colleagues or to build a research team to conduct the work. During the course of the analysis, two assessment team meetings were held to discuss progress, share data, and to coordinate work to the extent possible. These meetings were also open to the public and were structured in a way that allowed the team to conduct its business and to solicit public input and reactions to the team's efforts.

Preliminary findings were not discussed in open assessment team meetings. This was consistent with a policy that findings would not be released without careful peer review. A closed meeting of the assessment team was held in January 2001 to discuss preliminary findings and to improve the coordination of analyses of related questions.

### ***Reviewing the Results***

Answers to the questions were drafted as separate reports and summarized in a summary report, which compiled and synthesized major findings from the separate reports. These findings were then evaluated using a peer-review process patterned after standard approaches utilized by scientific journals. For each report, a number of experts (peers) were selected to review and comment on the accuracy and adequacy of the response. These experts were selected from a set of candidates provided by members of the public, by agency representatives on the planning team, and by the question managers themselves. A single-blind peer-review procedure was employed; i.e., the identities of the reviewers were kept confidential in order to obtain candid remarks on the reports. Reviews were compiled and returned to the authors of each report for consideration as they revised their chapters. The assessment coleaders managed the peer-review process, including evaluation of responses to reviews by the authors.

After the individual chapters were revised to address comments raised through peer review, they were released as draft reports. The draft reports (including the draft summary report) were published via the SFRA Web site, and the draft summary report was printed for distribution upon request (Wear and Greis 2001).

Draft reports were reviewed over a 90-day comment period. Comments were taken via a threaded message board organized by individual reports on the SFRA Web site and through the mail. As public comments were received, they were classified by specific points raised, were organized by chapter, and were distributed to authors. Comments were used to revise reports and to identify additional relevant data and research that had a bearing on the assessment questions.

Final products of the assessment include a technical report that addresses the individual questions (Wear and Greis 2002b) and the final summary report (Wear and Greis 2002a). They also include all data used in the analyses and complete documentation of data sources and

analyses. The availability of data and documentation is intended to enable the public to conduct followup analysis and to replicate the work conducted within the assessment. The data could also provide a benchmark for future updating of assessment findings.

### **ASSESSMENT FINDINGS**

The full suite of assessment findings is contained in the 23 technical reports that constitute the chapters of the SFRA technical report (Wear and Greis 2002b). The following sections summarize the major findings described in the SFRA summary report.

### **FORCES OF CHANGE**

We evaluated the forces of change that have reshaped and continue to reshape forests in five categories: (1) land markets, (2) timber markets, (3) social institutions, (4) biological factors, and (5) physical factors. While each of these areas defines important mechanisms of change, it is clear that they interact in their effects on southern forests. In each area, we examined the history and status of these changes and, where possible, explicitly projected potential changes.

#### ***Land Markets***

From 1700 to 1930, land clearing for agriculture and timber production completely restructured southern ecosystems. Clearing for agriculture greatly diminished the area of forested wetlands, especially in the Mississippi River Alluvial Valley. Agricultural uses reached their zenith in the late 19<sup>th</sup> century. Wholesale land abandonment then set the stage for a long period of forest reestablishment and growth.

Since the 1940s, there has been little net change in forest area in the South. Current forest area is 214 million acres, or about 91 percent of that recorded in 1907. However, there have been large offsetting changes: forest land has been converted to urban and agricultural uses in some places, and agricultural land has been converted to forest in others.

Forecasting models indicate that 12 million forest acres will be lost to urbanization between 1992 and 2020. An additional 19 million acres are forecast to be developed between 2020 and 2040. Forecasts also indicate conversion of 10 million acres from agricultural land to forest between 1992 and 2020 and conversion of another 15 million acres by 2040. Most forest loss is expected to be



concentrated in the eastern part of the South; forest gains are expected to be concentrated in the west.

### Timber Markets

Between 1952 and 1996, the South's timber production more than doubled. Its share of U.S. production increased from 41 to 58 percent, and its share of world production increased from 6.3 to 15.8 percent. The region now produces more timber than any other country in the world (fig. 5.2).

The South produces a great variety of timber products, including softwood saw logs (28 percent of the region's wood output), softwood pulpwood (25 percent), and hardwood pulpwood (16 percent). Since 1952, hardwood pulpwood has experienced the greatest increase in product share, growing from 3 to 16 percent of output.

Models of timber markets forecast that timber production in the United States will increase by about one-third between 1995 and 2040. Nearly all of this growth will come from the South, where production is forecast to increase by 56 percent for softwoods and 47 percent for hardwoods.

### Social Institutions

Laws, regulations, and Government programs are frameworks within which forests are managed. The current income tax code has mixed impacts on long-term investments in forestry, and inheritance taxes encourage owners to liquidate or split up forest properties.

Forest incentive programs that subsidize the planting of trees have had a long and successful history in the South. More recent programs focus on multiple values obtained from forests.

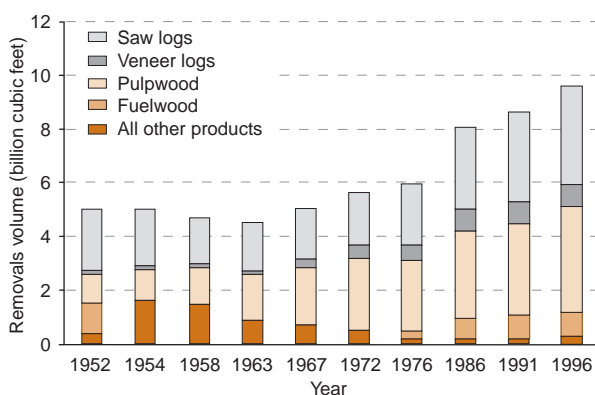


Figure 5.2—Removals by destination product, southwide, all species, 1952 to 1996 (Wear and Greis 2002a).

Direct regulation of forestry is limited in the rural South. However, in areas that are becoming more urbanized, a proliferation of local regulations has markedly affected land use and forest management. The number of such regulations nearly doubled between 1992 and 2000.

Funding of forest incentive programs is likely to vary depending on State and Federal priorities. The expansion of local regulations appears to be closely linked to population growth and urbanization. The number of regulations affecting forest treatments will likely continue to expand in high-growth areas.

### Biological Factors

Native plant diseases and insects affecting pines have become problematic for forest managers in the South as the species composition and configuration of pine forests has changed. Southern pine beetle (*Dendroctonus frontalis* Zimmermann) and fusiform rust (*Cronartium quercuum* f. sp. *fusiforme*) are economically significant pests.

Nonnative diseases and insects have altered and continue to alter southern forests, especially hardwood forests. Chestnut blight [*Cryphonectria parasitica* (Murrill) Barr [formerly *Endothia parasitica* (Murrill) Anderson & Anderson]] removed an important canopy species beginning in the 1930s. Several other species-specific diseases have been introduced to the South. These include dogwood anthracnose (*Discula destructiva*), oak wilt [*Ceratocystis fagacearum* (T.W. Bretz) J. Hunt], and butternut canker (*Sirococcus clavigignenti-juglandacearum*). Among the nonnative insects that have been introduced are the gypsy moth (*Lymantria dispar* Linnaeus), balsam woolly adelgid (*Adelges piceae* Ratzeburg), and hemlock adelgid (*Adelges tsugae* Annand).

Nonnative trees, shrubs, vines, birds, and mammals are also having large impacts on southern ecosystems.

The southern pine beetle is expected to continue to cause substantial economic damage and ecological change in the South, especially on heavily stocked nonindustrial private and aging public forests. Multiple nonnative diseases and insects affecting hardwoods will continue to spread from the North. Expansion of urban areas is likely to increase the spread of nonnative plants and animals and to affect native plant and wildlife communities.

## Physical Factors

Many southern forest types are fire adapted, and exclusion of fire has altered their species composition, flammability, and management. The reintroduction and continued use of fire will present challenges as concerns related to urbanization and air pollution become more important. The ambient environment influences forest growth and vigor. Ozone pollution is forecast to increase by 20 to 50 percent between 1990 and 2025, and growth reductions in southern pines are expected as a result. Future changes in temperatures could positively or negatively affect forest growth and species ranges depending on the extent of the change and the availability of moisture. Acid deposition is expected to significantly impact the region's forests only in the Southern Appalachians.

## SOUTHERN FOREST CONDITIONS

We also examined the current status and potential future of various aspects of forest conditions and the services and direct benefits that forests provide. We examined southern forest conditions from four different perspectives: (1) social and economic systems; (2) forest area and condition; (3) terrestrial ecosystems; and (4) water quality, wetlands, and aquatic ecosystems.

## Social and Economic Systems

**Social context**—The population of the South has grown faster than the national average (fig. 5.3). As a result, the share of the U.S. population residing in the South has increased to more than 32 percent. Although population growth occurred largely in urban areas through 1980, it has now spread across nearly all southern counties.

The South's population has also become more urban. These changes are reflected in values that have shifted away from a strong commodity orientation to a more biocentric view.

The South's population is forecast to continue growing, both absolutely and in relation to that of the United States as a whole, thus putting increasing pressure on forests, especially in urbanizing areas.

**People and forests**—Comparisons of the distribution of population and forests indicate areas in which access to forests and their benefits is especially limited. These areas are concentrated in Florida, in northern Virginia and northern Kentucky, and along interstate highway corridors

I-85 from Raleigh, NC, to Atlanta, GA; I-65 from Birmingham, AL, to Nashville, TN; and I-81 from Chattanooga, TN, to Wytheville, VA.

Forecasts for the period 1992 to 2020 indicate that there will be outward growth and increased human impacts on forests surrounding urban centers such as Atlanta, Nashville, and Charlotte and along the Atlantic and gulf coasts. These wildland-urban interfaces have effects on many forest values.

**Wood products**—With expansion in forest production has come an expansion in jobs and income derived from the wood products industry. In 1997, timber harvests led to more than 700,000 jobs in the wood products sector and more than \$118 billion in total industry output. Total economic impacts of these activities were about 2.2 million jobs (5.5 percent of total jobs) and \$251 billion of total industry output (7.5 percent of industry output).

Timber harvesting and management of timber production are prevalent in all parts of the region but are especially concentrated on the Atlantic and Gulf Coastal Plains.

It is predicted that timber production will increase most in areas to the north and west of the traditional timber production core of the South—that is, into Tennessee, North Carolina, Arkansas, and western Virginia (fig. 5.4).

Increases in timber harvests are not expected to deplete inventories, but there is considerable variability among States and forest types. Softwood inventories are forecast to increase gradually between 1995 and 2040. Hardwood inventories are forecast to expand between 1995 and 2025, but to fall slightly between 2025 and

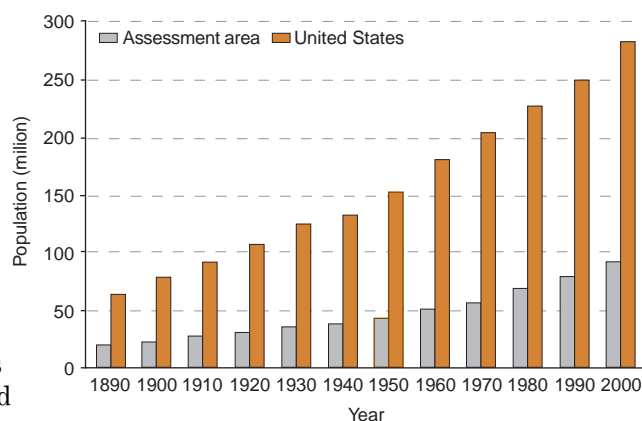


Figure 5.3—Population, in millions, for the United States and for the 13 States in the assessment area (Wear and Greis 2002a).

2040. This reflects forecasts that show hardwood removals exceeding growth regionally by about 2025, and sooner in some States.

**Recreation**—Southern forests provide opportunities for a broad array of recreational activities. Driven by a growing population and changes in income and other demographics, recreational uses of all types have increased. Recreation is an important source of employment and income in the South. In 1997, tourism based on outdoor recreation contributed between 0.64 and 2.88 percent of southern jobs. Recreation-based tourism on public lands represented 56 percent of this contribution. Much private land is unavailable for public recreation, and the trend is toward less access. Consequently, there is considerable pressure for increased recreational use of public lands.

Given current land ownership patterns, there appears to be limited capacity to expand forest-based recreational opportunities in the South. Recreational activities on public land are expected to be increasingly congested, and competition among various recreation groups will increase.

**Quality of life**—Forests contribute to quality of life in several ways. They provide for production of wealth by supplying wood products and recreational opportunities, they protect and enhance environmental quality, and they meet aesthetic needs.

Changes in the use of forests will affect the quality of life for local residents. Predicted increases in harvesting in areas outside the production core of the South may generate increased wealth for some persons, but loss of aesthetic and environmental benefits for others. This will probably lead to debate about forest uses in local areas.

### **Forest Area and Conditions**

**Forest area and ownership**—The South now has more than 214 million acres of forest land (fig. 5.5), 60 percent of the total in 1630 and 91 percent of the total in 1907 (fig. 5.6). Forest area has been relatively stable since the 1970s. Eleven percent of timberland (21.4 million acres) is managed by various Government agencies. The remaining 89 percent is privately owned. Twenty-two percent of private timberland is owned by forest industry, 21 percent by farmers, 12 percent by other corporations, and 45 percent by other individuals.

Ownership is changing with a decrease in forest industry ownership between the 1980s and 1990s and an increase in other corporate ownership, including ownership by timber investment management organizations.

Total area of forest land is forecast to decline by only 2 percent between 1995 and 2040. Preliminary results of the most recent forest inventories indicate that decreases in forest industry ownership are continuing.

**Broad forest types**—While total forest area has remained relatively constant, the distribution of forest types changed from the 1950s to the 1990s. The area of upland forest increased gradually. The area of lowland hardwood forest declined somewhat between the 1950s and 1970s but has leveled off. The area of naturally regenerated pine stands decreased by about half as the result of natural succession to upland hardwoods, harvesting of the pine component, or conversion to nonforest uses or planted stands following harvesting. The area in planted pine increased from about 2 million acres in 1953 to 32 million acres in 1999. In the 1980s and 1990s, pine plantations were established on land that previously supported hardwood or mixed pine-hardwood forests (47 percent), natural pine forests (28 percent), and agricultural fields (25 percent).

The area of pine plantations is forecast to increase by 67 percent to 54 million acres in 2040 (fig. 5.7). Areas of all other forest types are

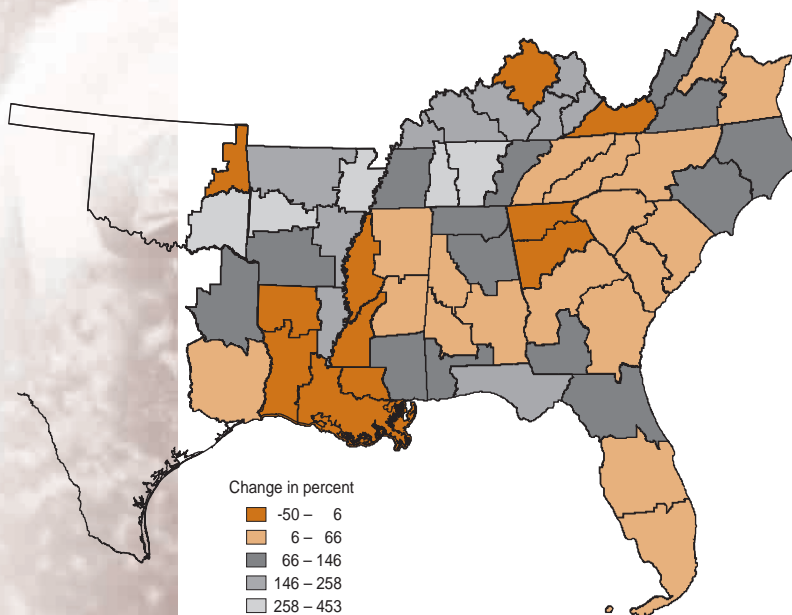


Figure 5.4—Forecast percent change in annual softwood harvest levels, 1995–2040, by survey unit of the Forest Inventory and Analysis Program of the U.S. Department of Agriculture Forest Service (Wear and Greis 2002a).



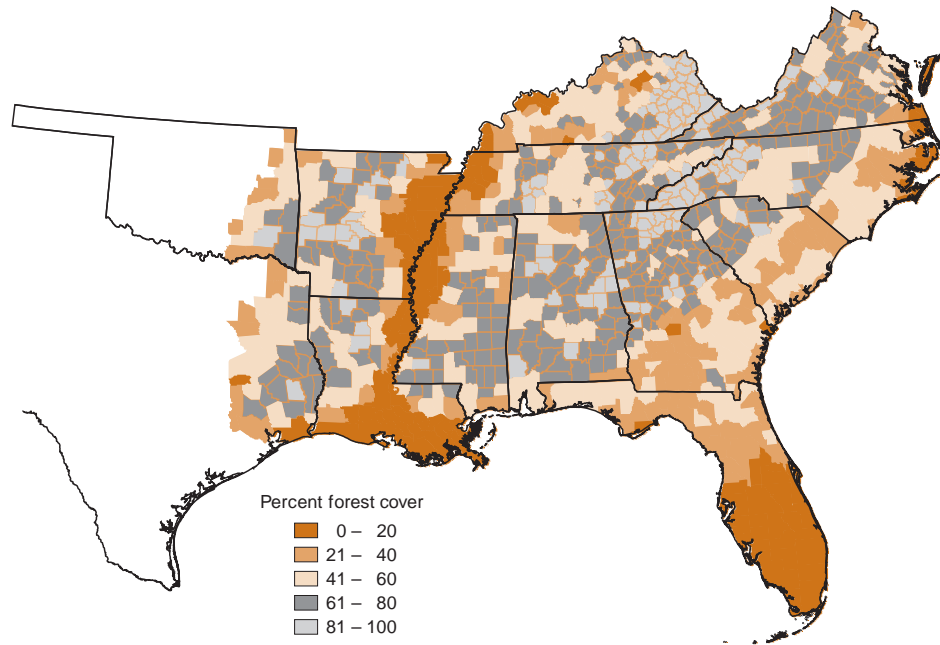


Figure 5.5—Percent of forest cover by county, 1992 (Wear and Greis 2002a).

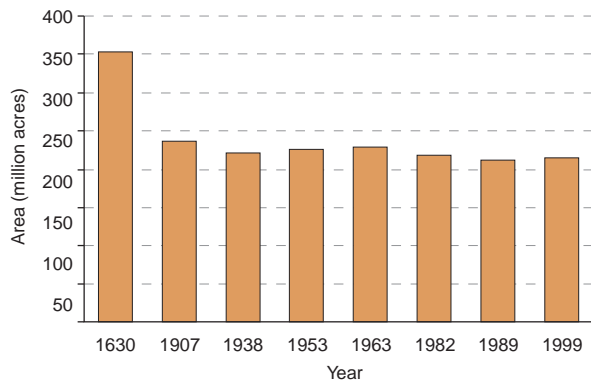


Figure 5.6—Forest area in the Southern United States, 1630 to 1999 (Wear and Greis 2002a).

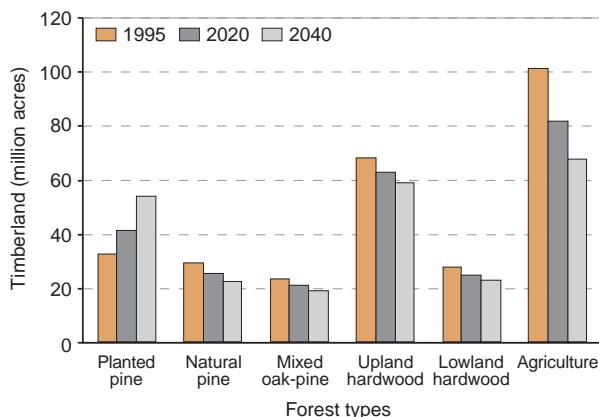


Figure 5.7—Forecast of the area timberland by forest types, 1995 to 2040 (Wear and Greis 2002a).

expected to decline gradually over this period. Forests of all types will be lost to urban uses and gains in acreage in planted pine will come mainly from planting of agricultural fields.

**Landscape structure**—Satellite images of forest cover in the early 1990s indicate areas where forest is highly contiguous. These areas include the Blue Ridge Mountains, the Cumberland Plateau, the Allegheny Mountains, the Ozark-Ouachita Highlands region, and some coastal areas. Areas where forest cover is highly fragmented include the Piedmont, central Tennessee, and the Ridge and Valley ecoregion.

Population growth and other factors are expected to make Piedmont forests especially susceptible to increased fragmentation through 2040.

**Forest inventory**—Southern forests accumulated considerable volumes of timber between the 1950s and 1990s. Inventory grew from 148 to 256 billion cubic feet, reflecting rapid growth of stands established since the 1930s. Recent inventories indicate a general slowing in the rate of accumulation for hardwoods and a leveling off of accumulation for softwoods.

Forecasts indicate that softwood growth will overtake and exceed removals by a slight margin in the next few years. As a result, softwood inventories are predicted to increase steadily

between 1995 and 2040. Hardwood removals are expected to outstrip growth by about 2025. Hardwood inventories are forecast to peak in about 2025 and then decline to levels just exceeding current ones by 2040.

**Timberland productivity**—Intensive management has increased southern timber yields. Yields associated with high-intensity management can be 65 percent greater than those associated with standard site preparation and planting, and more than double the yields from naturally regenerated forests.

Future productivity is a key determinant of both future forest conditions and future of timber market conditions. For example, models suggest that if anticipated productivity gains were not realized, more pine plantations would be established to supply timber products. The effects of climate change, other environmental change, and pest-related mortality on productivity are less certain.

### **Terrestrial Ecosystems**

**Abundant forest communities**—Upland hardwood and pine forest types remain plentiful in the South but are subject to several health problems. Southern pine beetle has had a greater economic impact than any forest pest over the past 30 years. The chain of forest changes begun by the chestnut blight continues; the latest of these changes may be a disease complex called oak decline, which is especially severe in the Southern Appalachians and the Ozarks.

Southern pine beetle will continue to be an economically important pest of pine forests. Epidemics are likely where pines have been planted outside of their natural range and in the absence of active management. Spillover epidemics from public land may continue to be a problem in the South. The complex of nonnative insects and diseases affecting hardwoods has the potential to restructure forests, especially in the northern part of the region.

**Rare forest communities**—Many concerns about southern wildlife and plant species focus on rare forest communities. Fourteen critically endangered communities have lost more than 98 percent of their habitat since European settlement. Most of these communities are in seven classes: (1) old growth; (2) spruce-fir (*Picea* spp.-*Abies* spp.); (3) wetlands, bog complexes, and pocosins; (4) bottomland and flood plain forests; (5) glades, barrens, and prairies; (6) longleaf pine

(*Pinus palustris* Mill.) forests; and (7) Atlantic white-cedar [*Chamaecyparis thyoides* (L.) B.S.P.] swamps.

Two of the seven classes—old-growth and spruce-fir forests—are found largely on public land. The remainder are generally in private ownership, so their future depends on the decisions of numerous owners. Spruce-fir appears to be under the greatest stress—stress caused mainly by air pollution and a nonnative insect. Remnant longleaf pine forests are threatened by land development and fire exclusion.

**Effects of land use changes**—Urbanization affects bird populations by fragmenting or eliminating habitat and by increasing disturbances. Nonnative animals, for example, feral cats, dogs, and pigs, influence wildlife through predation, displacement of native species, and habitat modification.

Predicted changes in land use may affect bird species most adversely in the Piedmont, where population declines are anticipated for neotropical migrants and forest interior specialists.

**Effects of forest management**—Forest management can have important implications for wildlife. Impacts depend on specific site conditions and the management practices employed. Broader landscape patterns can influence mobile wildlife species. Fragmentation effects of certain practices are likely to be lower in heavily forested areas than in areas where urban and agricultural uses predominate such as the Piedmont, Interior Low Plateau, and Mississippi Alluvial Plain. Effects of landscape configuration and forest management may be especially important for some species, especially certain amphibians. Across the South, more species are threatened by increased isolation of shrub-scrub and grassland habitats than are affected by scarcity or fragmentation of mature forests.

The ultimate future challenge for forest management is to support the array of grassland, shrub-scrub, and mature forest species occurring within the same landscapes.

**Wildlife species of concern**—Of the 1,208 vertebrate species known to exist in the South, 132 are considered to be of conservation concern and 28 are classified as critically imperiled. The South is the center of amphibian biodiversity in the United States. Fifty-four amphibians are classified as species of concern, and 19 are critically imperiled. Areas where the concentration



of endangered species is high include the Southern Appalachians, the Atlantic and Eastern gulf coast flatwoods, the gulf coast marsh and prairie, and peninsular Florida (fig. 5.8). Loss of habitat is the primary cause of species endangerment.

Habitat protection will be difficult in view of the rapid urbanization forecast for the South. Forestry operations can have impacts on certain amphibians, especially those that depend on both wet and upland habitats.

**Conservation issues**—Public land is relatively scarce in the South (11 percent of forest acreage) but plays an important role in conservation of specific forest types and wildlife species. More often, the management of private land determines the future of imperiled species and rare forest communities. Effective conservation often requires collaboration, giving rise to multiple-owner consortiums.

Although scarce, public land has unique ecological value because it can provide a dependable supply of interior forest habitat and older forests. In areas that are becoming urban, public tracts can serve as anchors for conservation strategies pursued by multiple owners. The effective reintroduction of fire to many forest ecosystems will remain a critical forest conservation challenge.

### ***Water Quality, Wetlands, and Aquatic Ecosystems***

**Water quality**—About 30 percent of the South has relatively good water quality, 36 percent has moderate water-quality problems, and 15 percent has serious water-quality problems. The leading causes of water-quality impairment have been siltation, pathogens, and nutrients. Of the 11 major sources of water-quality impairment, agriculture

and urbanization have ranked highest, with silviculture ranking next to last. When properly implemented, best management practices (BMP) are effective in controlling pollution from silvicultural activities. Twelve of the thirteen Southern States have monitored BMP compliance and reported results. Because different States employ different survey methods, regional trends cannot be identified. However, consistency among States is improving; six States have adopted similar procedures since 1997.

As timber production increases in the South, effective BMP implementation will become even more crucial for protecting water quality.

**Wetlands**—Approximately 32.6 million acres of forested wetlands occur in 10 Southern States (those that constitute the assessment area minus Virginia, Texas, and Oklahoma). These wetlands account for 64 percent of the total forested wetland area in the conterminous United States. Losses of forested wetlands have been quite widespread, but have been noticeably concentrated in the Mississippi Alluvial Valley and the Coastal Plain of the Carolinas. Rates of loss have declined since the 1970s, but impacts and functional changes continue to occur.

Land management practices and urbanization are expected to continue to alter the function of wetlands. Wetland restoration efforts will continue, but their likelihood of success is not clear. Forest management practices will play an important role in the persistence of certain amphibian species.

**Aquatic species of concern**—The South supports a great diversity of aquatic species. Several hundred species of concern are found among the amphibians, mussels, crustaceans, fish, snails, and aquatic insects of the region. Especially high numbers of mussel, fish, and amphibian species are critically imperiled as a result of modification to aquatic and wetland habitats (fig. 5.9).

For many mussels and certain other species, declines will continue because of the effects of essentially irreversible actions such as dam construction, agricultural conversions, and the introduction of nonnative species. Many aquatic species of concern are narrow endemics. The effects of development and management activities may be disproportionately large for the small areas they occupy.

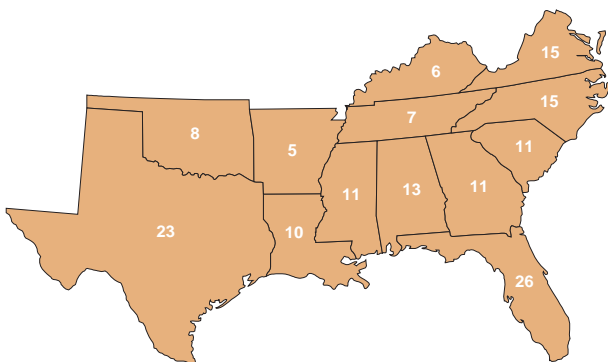


Figure 5.8—Number of terrestrial vertebrates in Southern States listed as endangered (Wear and Greis 2002a).

## DISCUSSION

The findings of the assessment led us to some broad observations regarding the present and future status of southern forests.

1. The South is an economically, culturally, and ecologically complex region, and a number of forces of change are affecting its forests.
2. Urbanization presents a substantial threat to the extent, condition, and health of forests. Of the various forces of change, urbanization will have the most direct, immediate, and permanent effects on the extent, condition, and health of forests.
3. The population of the South is growing, and the social context of forest management is changing. These changes have implications for the nature of values and demands that people place on forests as well as on the uses of forests.
4. Total forest area will remain stable, but subregional and compositional changes will continue. We forecast little net change in the total area of forests between 1995 and 2040. Losses of forest area to urban uses are expected to be offset by shifts from agricultural to forest uses. Urban development is forecast to be concentrated in eastern areas, while afforestation of agricultural land is expected to take place largely in the western part of the South. Overall, the southern region will experience a westward shift in its forest area.
5. Timber production is forecast to expand, but it is not expected to deplete forest inventories below current levels. Between 1995 and 2040, softwood outputs will expand by 56 percent and hardwood outputs by 47 percent. Softwood inventories will continue to expand throughout that period. Hardwood inventories will expand until 2025 and then decline slightly between 2025 and 2040.
6. Investment in pine plantations is forecast to expand to meet increased softwood demand. This will have implications for the ecological characteristics of southern forests. Pine plantations enhance timber productivity. For example, planted forests accounted for only 15 percent of timberland, but they contributed 35 percent of annual softwood removals during the 1980s and 1990s. Increases in pine plantation acreage could also result in varying ecological changes, depending on stand origin and management. These effects are better documented at the forest stand level than at a broader landscape scale.
7. Changing patterns of land use and harvesting will have important effects on the lives of the people of the South. The wood products industry now accounts for about 6 percent of jobs and 8 percent of income in the region. In some rural parts of the South, these percentages are much higher and forest-related industry has represented more than half of the local base economy. Forests also contribute to the quality of life in the region by providing opportunities for recreation, visual backdrops, and environmental quality. Forecasts of increasing timber harvests imply more jobs in the wood products sector. However, abrupt changes in forest conditions could lead to increased costs for some people, increased benefits for others, and increased debate over forest uses in areas outside the traditional production core of the South.
8. Southern forests have proved to be resilient, but some components are scarce and are, therefore, at risk. Through the 20<sup>th</sup> century, the South has recovered from a largely cutover, exhausted, and eroded condition to become one of the most productive forest regions in the world. However, there are reasons for concern. Among these are the presence of numerous imperiled animal species (28 terrestrial vertebrates are critically imperiled) and increasingly rare

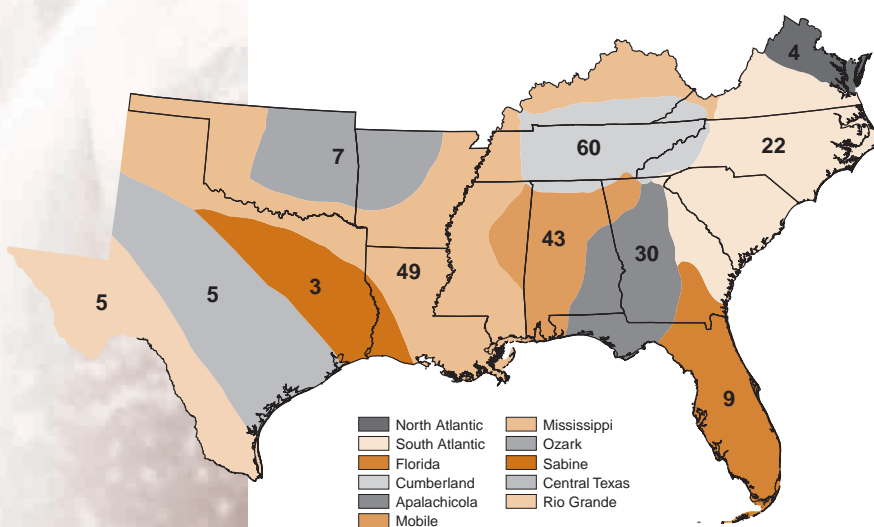


Figure 5.9—Distribution of mussel species by aquatic fauna provinces (Wear and Greis 2002a).

forest communities (14 communities have been reduced to < 2 percent of their area at the time of European settlement).

9. To borrow the adage from economics, scarcity defines value. The rare forest communities in the South have disproportionately high ecological value. Thus, much concern about biodiversity is focused on these relatively small shares of the forest landscape.

### ***Subregions of Concern***

The assessment also allowed us to define where change and the potential implications of change are focused within the South. In particular, we identified three areas in the region where concerns regarding forest sustainability may be especially high. These are (1) the Southern Appalachians, (2) the Piedmont, and (3) the Lower Atlantic and Gulf Coastal Plains. In the following discussion, these regions are considered individually.

**Southern Appalachians**—This region will be influenced by a combination of human, biological, and physical factors over the next two decades. Population growth and land use changes will increase the human presence in many forests. Demands for forest-based recreation are focused on the Southern Appalachians, and increased competition among recreation user groups is anticipated. A complex of forest health issues is affecting all forest types in this region and has the potential to restructure forest ecosystems there.

**Piedmont**—The Piedmont, from Virginia to Georgia, is expected to lose more forest area than any other part of the South. This heavily forested region already has a very low ratio of interior forest to total forest, indicating a high degree of forest fragmentation. Fragmentation is likely to continue with growth of populations in urban counties and interspersed rural counties. Consequently, wildlife habitats will be altered for certain neotropical migrant and other important bird species. Because populations will grow and forest area will decline, we also expect an increasing scarcity of forest-based recreational opportunities for city dwellers.

**Lower Atlantic and Gulf Coastal Plains**—Coastal flatwoods areas are forecast to lose much of their forest area to urban development. Forest loss combined with intensified forest management could have cumulative negative effects on coastal wetlands, both through direct wetland loss and through modification of hydrological regimes. The

flatwoods, one of two areas in the South with the highest concentrations of endangered animal and plant species, contain many imperiled amphibians, crustaceans, and reptiles. These problems are of especially great concern in the Florida Panhandle.

### ***Implications of the Assessment for Forest Research***

At the conclusion of an effort such as the SFRA, it is important to consider what we were unable to do. In contrast to most bioregional assessments conducted in the United States to date, which have been motivated by a crisis of one sort or another (Gordon 1999), the SFRA can be viewed as an “anticipatory assessment” (Johnson and others 1999). It was intended to provide a complement of information to illuminate a dynamic resource situation and illustrate critical areas before an actual crisis erupted.

The assessment was successful in describing several emerging issues that could affect the sustainability of the South’s forests, but more information is needed to better identify problems and potential solutions. Each technical chapter of the assessment identifies research needs, and eight broad areas of investigation were highlighted. The following are some key areas of uncertainty:

- The effects of population growth on forest ecosystems
- The influence of changing market and other values on land use and management choices
- The determinants of overall forest productivity for all benefits
- Forecasts of changes in ecological structure and functions
- Broadening the scale of forest research to better address questions at regional levels
- The role of fire in forests and the effective use of fire
- The influence of changing forest structure, and especially the influence of pine plantations, on ecosystem function and wildlife
- Developing new forest management strategies for a variety of settings

A finding from the assessment as a whole is the inability to fully link findings into an integrated multidisciplinary analysis of forest ecosystems. The assessment highlights the fact



that fundamental knowledge in various disciplines cannot yet be readily integrated to address the full complexity of a dynamic and highly diverse region.

Such an analysis would, for example, allow us to directly evaluate the impacts of expanded demand for wood products on the distribution and condition of wetlands and subsequently on the distribution and persistence of related species. Our inability to make these causal links reflects a shortcoming of ecosystem and resource science in general that is at its root the result of the form of scientific investigation. This defines an important challenge for the South's forest research community.

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